PROTOTYPE IP SATELLITE NETWORK

Kathy Newtson

Faculty Advisor :Dr. Stephen Horan

New Mexico State University

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Overview

- What the project is about: Prototyping an IP satellite network in the lab to demonstrate the quality and security of the IP communication architecture.
- Prototype Goals
- Expected Outcomes
- Issues to address

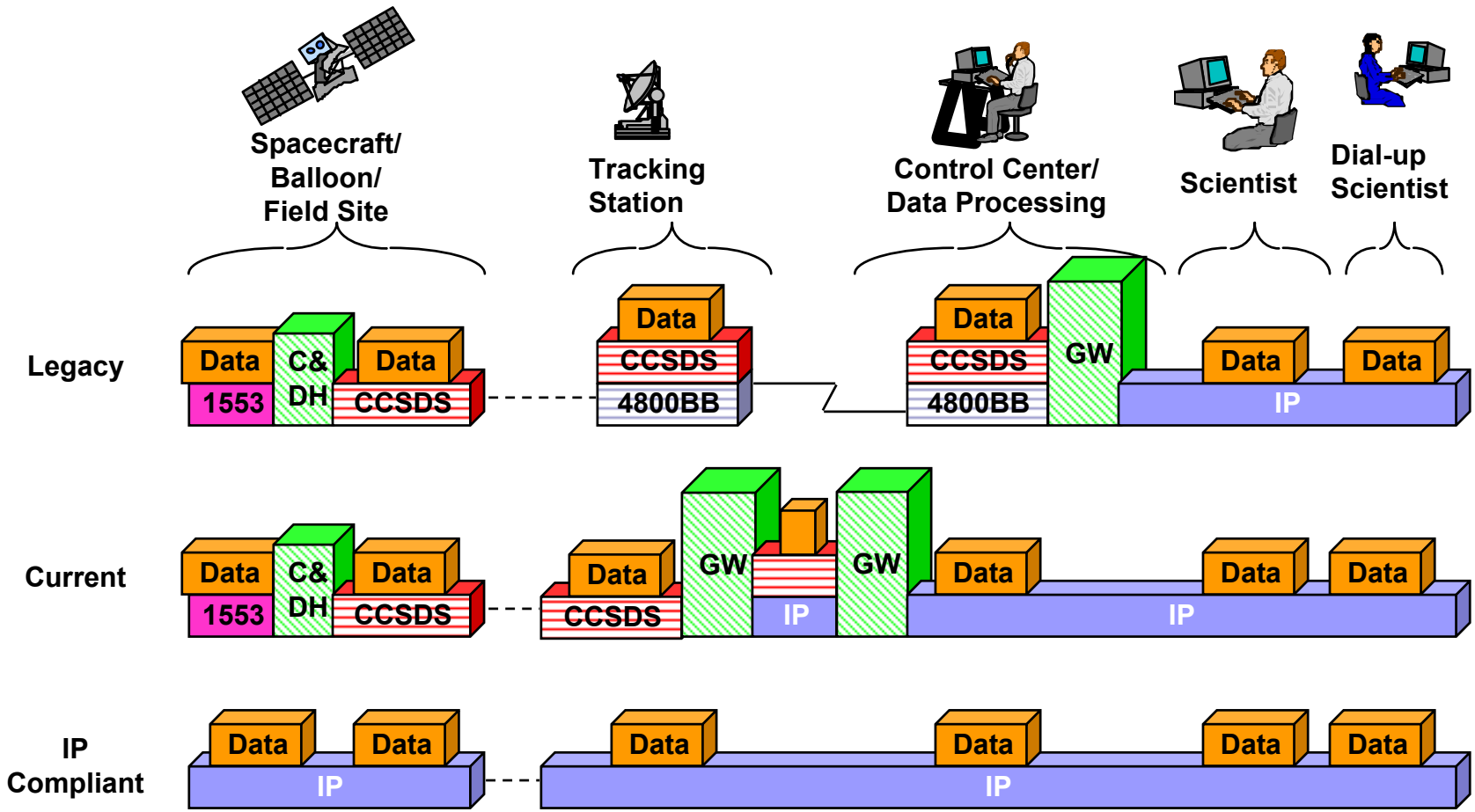
Prototype Goals

- Prove seamless and secure communications between the satellites and ground stations.
- Use COTS equipment
- Improve communications while minimizing development costs.

Expected Outcomes

- Assist NASA in making the architectural evolution from a legacy switched communication system to a full packet routed system with minimal human intervention.
- Demonstrate how commercial technology can be readily adapted to fulfilling the space communications needs.
- Demonstrating that ‘test as one operates, operate as one tests’ can be applied.

Expected Outcomes



Issues to Address

- Security
- Different IP protocols with varying packet sizes and types
- Network loads
- Reliable communications from satellite to ground

IP Network Design

- Constraints
- Candidate Mission Models
- Baseline requirements
- Prototype Block Diagram
- Modeling the Link

Constraints

- Design will need to support a variety of mission needs
- An actual satellite radio system will provide error-correction encoding

Candidate Mission Models

- Smallsat to nanosat mission support
- Science Mission Support
  - Advanced Cosmic ray Composition Experiment for Space Science (ACCESS)
- Note: Chosen because these had firm data specifications.

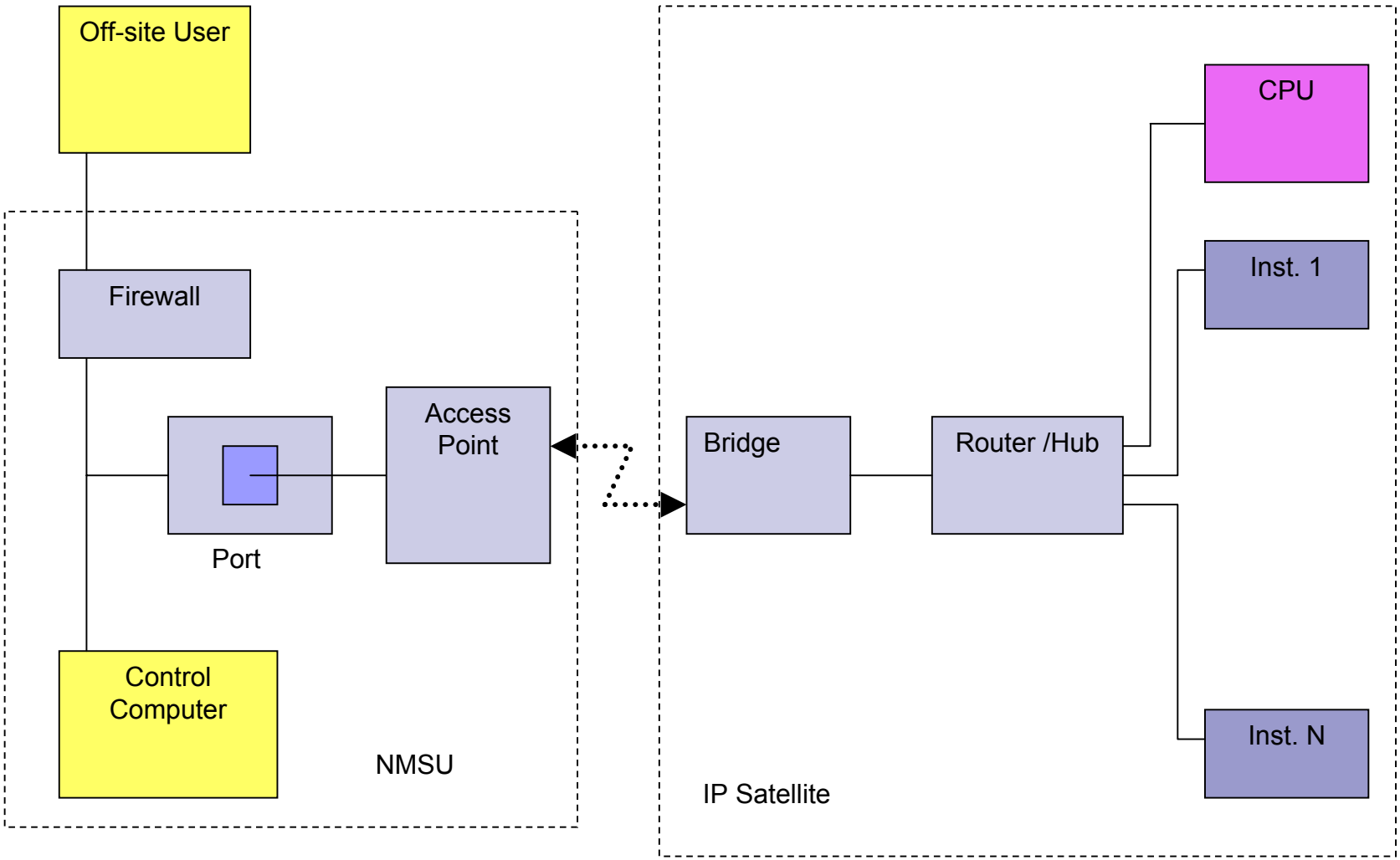
Baseline Requirements

- Data Requirements - Based on candidate mission models
  - Forward data rate of at least 9 600 bps
  - Simultaneous return data rate of at least 100 000 bps for science data and 15 000 bps for housekeeping data (two virtual channels)
- Data Structures
  - Science data arranged as files
  - Housekeeping data arranged as either real-time (streaming) or file data

Baseline Requirements

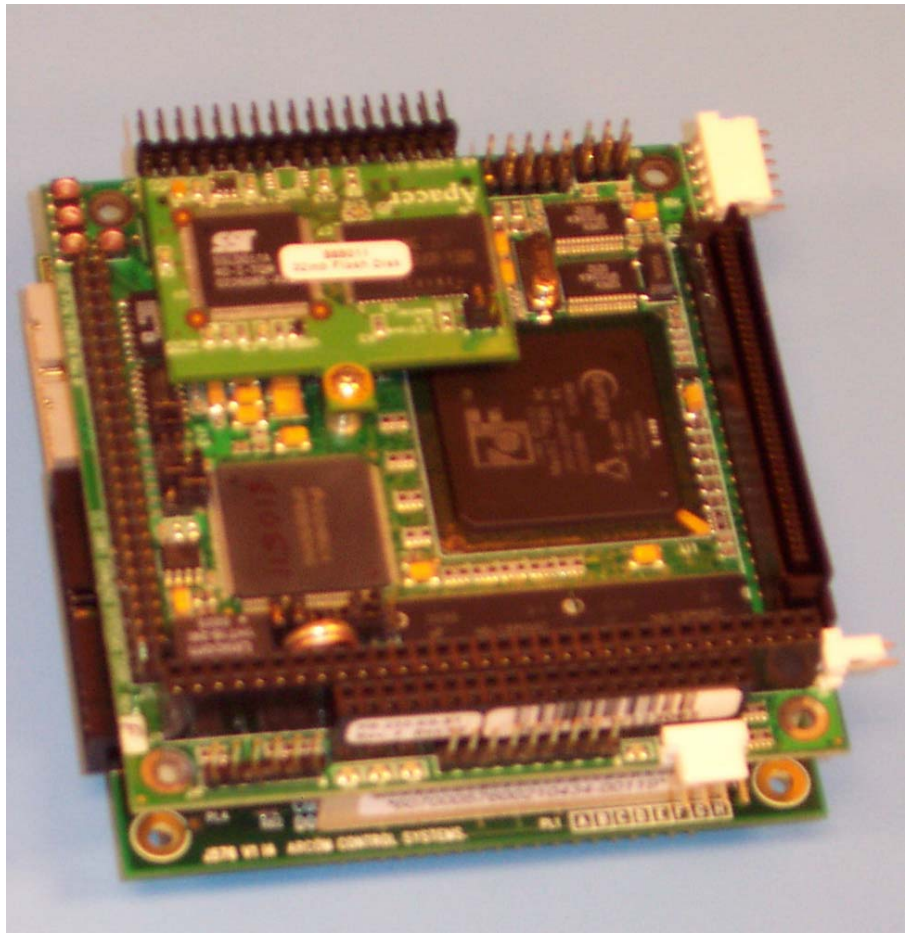
- Security
  - Provide VPN capabilities
  - Provide SSH login ability
- Services to be supported
  - *Telnet* to flight computer and instruments
  - *ftp* to flight computer and instruments
  - *Finger* service to instruments to obtain meta-TEDS file

Prototype Block Diagram



Prototype – Satellite CPU

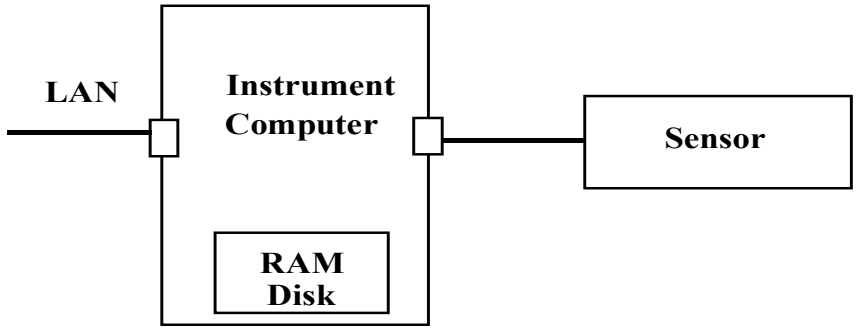
- Diamond Systems *Prometheus*
  - Small size
  - 16 ADC channels
  - 10/100 Base-T Ethernet
  - 4 serial, 1 parallel, 2 USB, & IrDA ports
  - Low power consumption

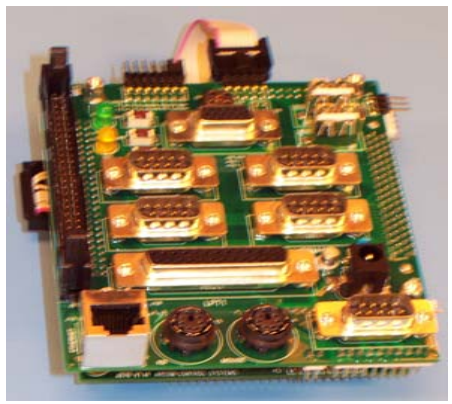


Prometheus PC/104 computer board

Prototype – Instrument concept

- Instrument = Computer, RAM, and sensor(s)
- Local connection, e.g. USB or serial, between sensor and computer
- RAM disk for non-real-time storage and instrument data

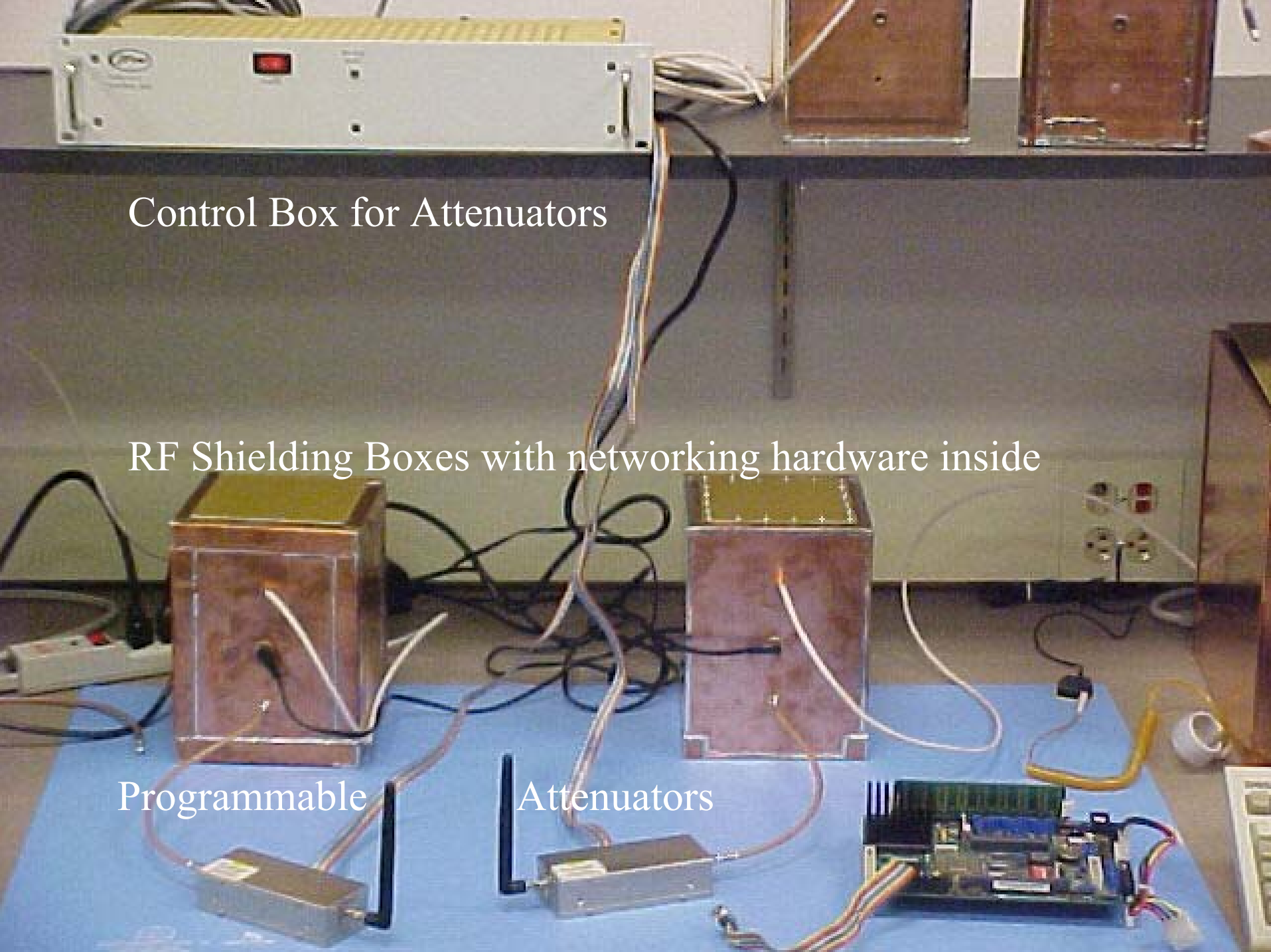




PC/104 interface Board for serial & LAN connections

Modeling the Link

- Satellite modeled in STK (Analytical Graphics, Inc.)
- Estimated antenna gains are 10 dB for Satellite, 60 dB for Ground Station
- RF Shielding boxes, and programmable attenuators
- Using LabView to simulate delay and channel error scenarios


Control Box for Attenuators
RF Shielding Boxes with networking hardware inside
Programmable
Attenuators

Prototype Results

- RF Shielding
- Validation
- Testing to be done

Prototype Results – RF Shielding

RF Signal levels at Client#1 = 0dB (open box) and Client#2 = 1dB

```
Aironet AP4800E V7.22          SIGNAL LEVELS          AP4800E_25979c
UC4800E   0040961531e4 Strength In  ****************************************
                               Out  ****************************************
                           Quality In  ******************************
                               Out  ******************************
UC4800E   004096153127 Strength In  ****************************************
                               Out  ********************************
                           Quality In  ********************************
                                Out  ******************************
```

RF Signal levels at Client#1 = 40dB and Client#2 = 80dB

```
Aironet AP4800E V7.22          SIGNAL LEVELS          AP4800E_25979c
UC4800E   0040961531e4 Strength In  ****************************
                               Out  ************************
                           Quality In  ******************************
                               Out  ****************************
UC4800E   004096153127 Strength In  ******************
                               Out  **************
                           Quality In  ********************************
                               Out  ********************************
```

Prototype Results

- Validation
  - Basic Test of connectivity and socket operation from local and remote ground locations to flight computer, and instruments.
  - Basic Test of SSH from both ground locations

Further testing

- With attenuators and RF isolation boxes simulate channel error performance
- Reliable transmission in the presence of channel errors
- Change data rate and/or frame size for high-error channels
- Real-time streaming of data, e.g. GPS data

Thanks!

- Are there any questions?